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HIGH VOLTAGE NANOSECOND PULSE GENERATOR.(U)
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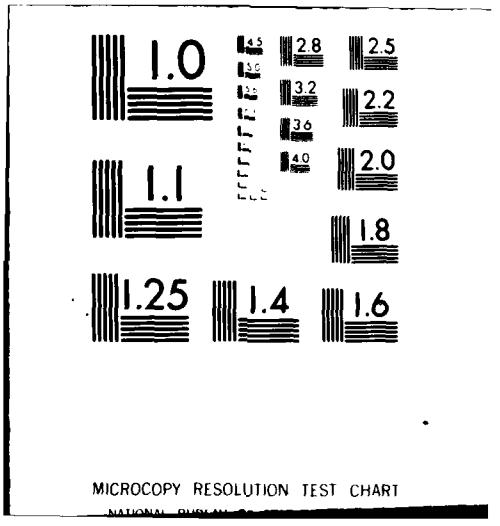
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RESEARCH AND DEVELOPMENT TECHNICAL REPORT

DELET-TR-77-2641-5

HIGH VOLTAGE NANOSECOND PULSE GENERATORS

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May 1980

Fifth Interim Report for Period 1 May 79 - 31 Oct 79

Prepared for:
Electronics Technology & Devices Laboratory

ERADCOM

US ARMY ELECTRONICS RESEARCH & DEVELOPMENT COMMAND
FORT MONMOUTH, NEW JERSEY 07703

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1. REPORT NUMBER: DELET-TR-77-2641-5	2. GOVT ACCESSION NO.: AD-A087 291
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE (and Subtitle): High Voltage Nanosecond Pulse Generator	5. TYPE OF REPORT & PERIOD COVERED: 5th Interim Technical Report 1 May 1979 - 31 October 1979
	6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): C. Zavales	8. CONTRACT OR GRANT NUMBER(s): DAAB07-77-C-2641
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Cober Electronics, Inc. 7 Gleason Avenue Stamford, CT 06902	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 62705 1L762705AH94 02-01
11. CONTROLLING OFFICE NAME AND ADDRESS: USA Electronics Technology & Devices Laboratory ATTN: DELET-BG Fort Monmouth, NJ 07703	12. REPORT DATE: July 1980
	13. NUMBER OF PAGES: 9
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): Interim technical report 1 May 79 - 31 Oct 79	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Pulse Generation
Switching
Spark Gap
Blumlein
Avalanche Transistor

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A parallel Blumlein circuit, combined with a spark gap switch, was designed for operation at 24 kV, 5,000 A peak. Tests were conducted with a single Blumlein with a 10 ohm load. Because of problems with breakdown in the triggered spark gap, a slightly larger spark gap was substituted. An acceptable pulse is delivered from the pulse forming network after adjustment of the inductive elements in the network.

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I. INTRODUCTION

This report covers work during the period 1 May 1979 to 31 October 1979 on Contract DAAB07-77-C-2641 to develop a pulser for a TEA laser with a 10 mm gap. This is Task I. For Task II a pulser for a TEA laser is the same as for Task I, but operates at a variable PRR. The PRR for Task I is 15Hz. The work is being performed by Cober Electronics in Stamford, Connecticut for the U. S. Army Electronics Command, Fort Monmouth, New Jersey. The work is directed towards fulfilling the requirements of Task I and Task II Technical Guidelines entitled "High Voltage Nanosecond Pulse Generators" dated 18 December 1978. Listed below are the requirements for Task I and Task II.

Task I Requirements

Output Voltage	:	24 kV
Peak Current	:	5000 A
PRR	:	15 Hz
Pulsewidth (50%)	:	100 ns
Risetime	:	30 ns max
Pulse Energy Output	:	12 J
Pulser Efficiency	:	90% min (resistive load)
Life	:	4×10^6 pulses min
Weight	:	3.0 kg max
Volume	:	1200 cm^3 max

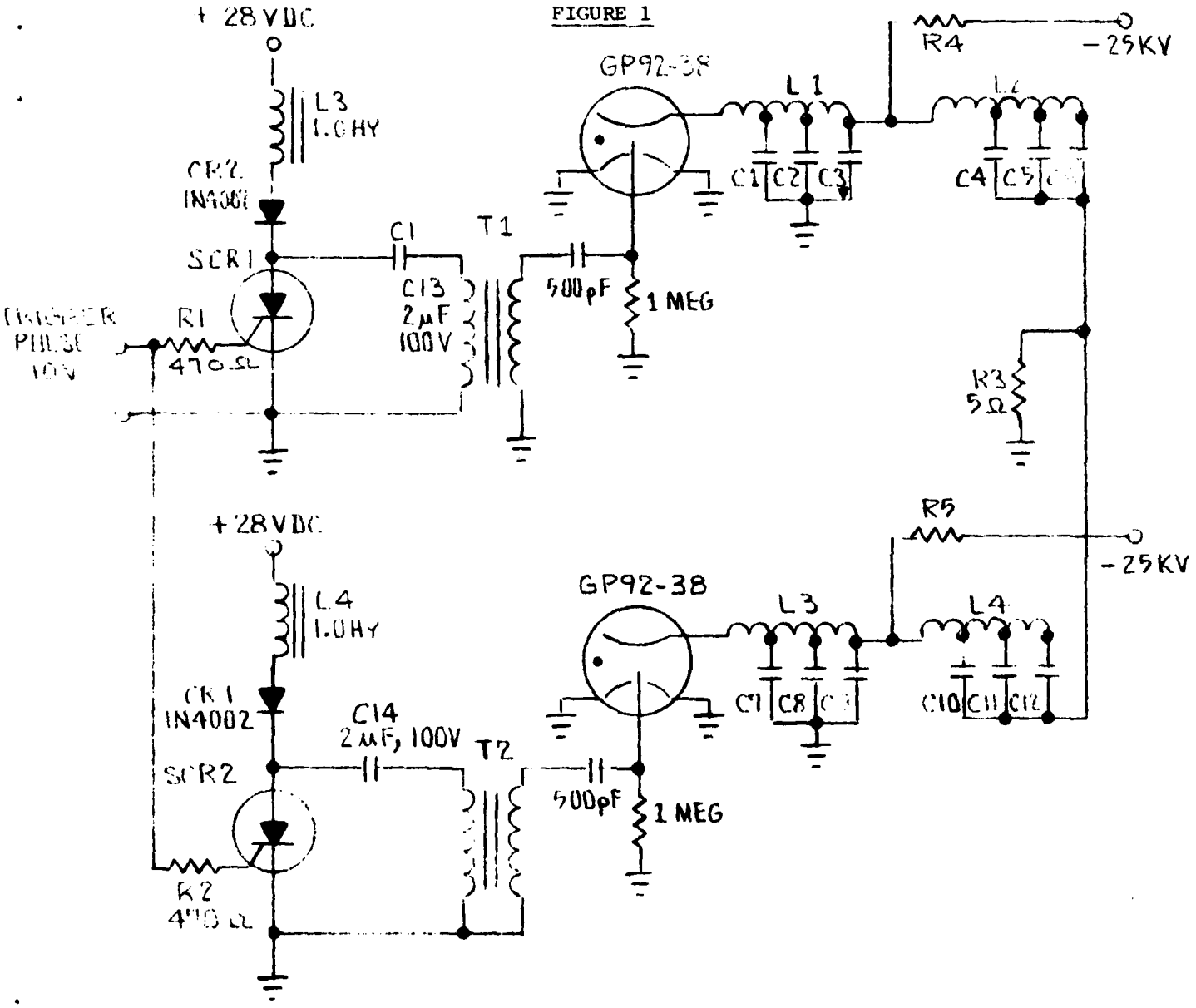
Input Battery Voltage	:	28 V
Mode of Operation	:	30 sec burst
Interval Between Bursts	:	60 sec

Task II Requirements

Output Voltage	:	24 kV
Peak Current	:	5000 A
PRR	:	1 to 20 Hz variable, & single shot
Pulsewidth (50%)	:	100 us
Risetime (10 to 90%)	:	30 ns min
Pulse Energy Output	:	12 J
Pulser Efficiency	:	90% min
Weight	:	3.0 kg max
Volume	:	1200 cm^3 max
Input Battery Voltage	:	28 V
Mode of Operation	:	30 sec burst
Interval Between Bursts	:	60 sec

The original approaches are shown in Figure I.

FIGURE 1



L1, L2, L3, L4 = .25 uh.

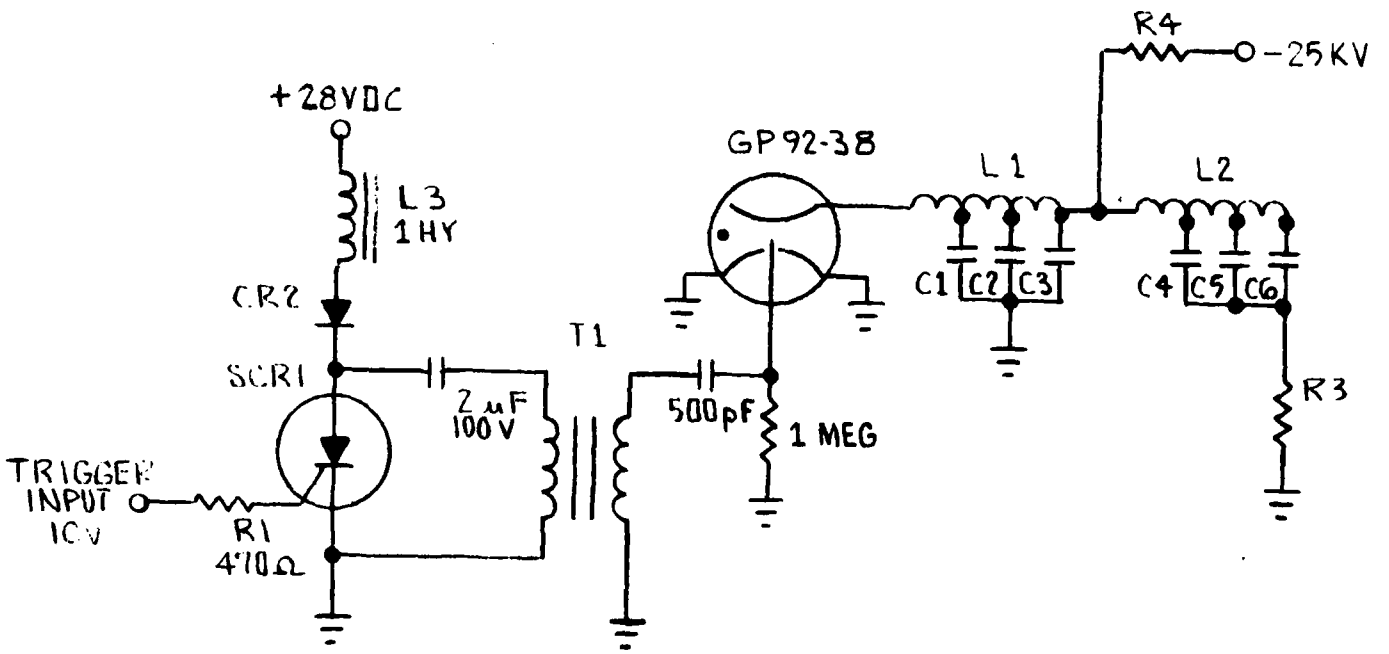
C1-C12 = 3300 PF, 30KV

R4-R5 = .5 meg

T1, T2 = TR 1647 by E.G.& G.

To simplify the engineering appraisal, the original schematic shown in Figure I was reduced to the schematic shown in Figure II. The rating now was 250 amperes at 24kV into a 10 ohm load.

FIGURE II



L1, L2 = .25 uh.

C1-C6 = 3300 PF, 30KV

R4 = 15 meg

T1 = TR 1647 by E.G.& G.

An assembly in accordance with Figure II was constructed. Several problems were apparent. T1 did not provide sufficient voltage to trigger the GP92-38 trigger gap, 15KV was needed. Another triggering circuit was constructed using 250VDC and a TR1700 trigger transformer. Another problem became apparent. The GP92-38 required immersion in oil because surface breakdown between the trigger electrode and adjacent electrode occurred.

Further testing revealed still another problem. The SCR1 occasionally did not turn off, especially when a burst of trigger pulses were used. A redundant external commutating circuit was in order or a power mosfet transistor was desirable. The power mosfet transistor was chosen in the interests of simplicity and reliability.

In view of the triggering problems and necessity for oil immersion, a larger trigger gap, GP-87, was substituted. This would simplify the final circuit arrangement. The GP-87, while slightly larger than 2 each GP92-38 trigger gaps, also has a higher output electrode rating of 2000 joules versus 50 joules for the two GP92-38 trigger gaps.

The assembly was now in accordance with schematic shown in Figure III.

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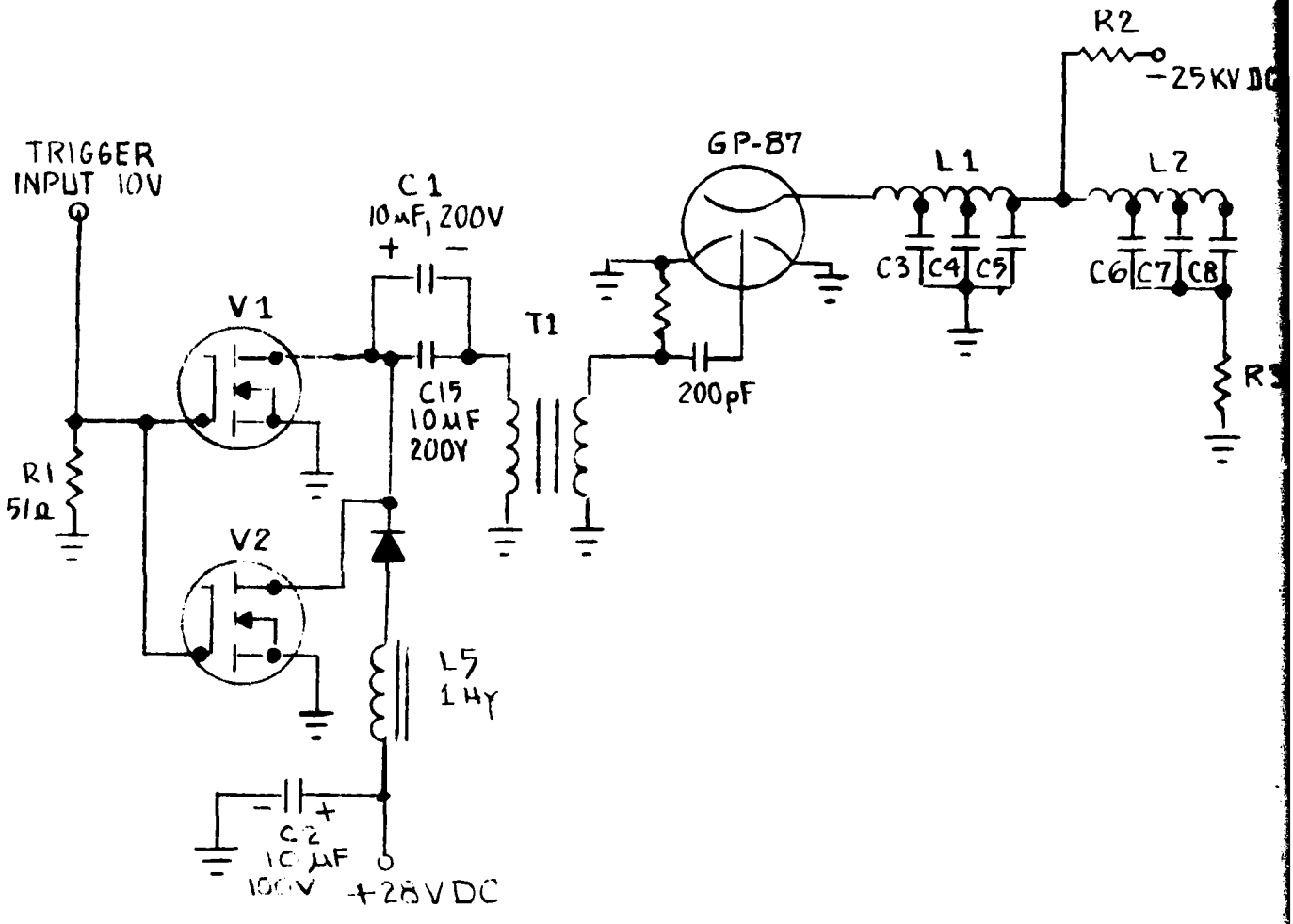
FIGURE III



V1, V2 - Power Mosfet IRF 133 by International Rect. Semi

T1 - TR1938 by E.G. & G.

GP87 - Trigger Gap by E.G. & G.

L1,L2 - .25 uf. inductance by Cober

C3-C8 - 3300 PF, 30KV

R3 - 10 ohm Load Resistor

R2 - .5 meg

The pulse forming network, a Blumlein configuration was examined. Initial efforts did not produce an acceptable pulse across the load resistor R3. The mechanical arrangement of the pulse forming network required a change. While the average power into the load was low, especially in a one shot mode, still the peak currents were high, 2500 amperes as a goal. Additionally, a reasonable match between the impedance of the network and the load was required to obtain a satisfactory pulse shape.

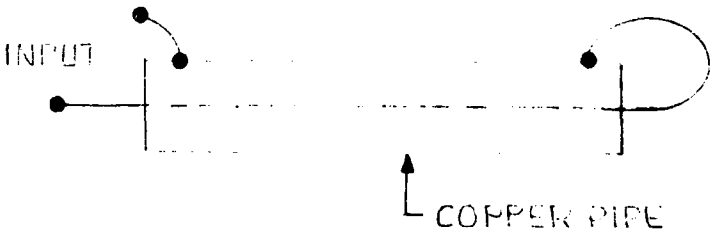
When a mechanical arrangement minimizing interconnecting lead lengths and strip conductors were used, satisfactory amplitude and pulse shape was achieved. In the final prototype these considerations will get attention.

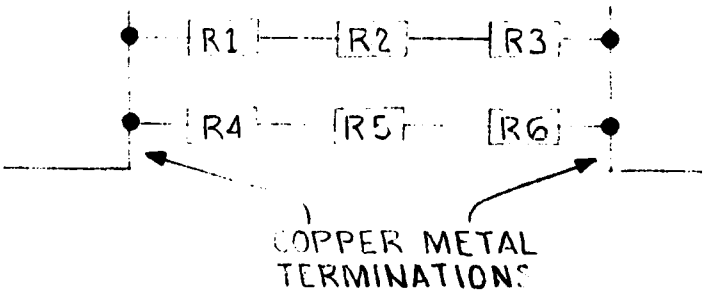
Figure IV represents the planned configuration to achieve the specified current of 5000 A and the specified voltage of 24kV across the load resistor. Additionally, the trigger input, while not specified, is desired as at a TTL level (3-4V peak) instead of the 10V used in the testing. A suitable arrangement was devised and is shown on the schematic.

An assembly in accordance with the schematic in Figure IV was made. The circuit to accept TTL trigger input was omitted initially. At the time, the unspecified but desirable requirement of TTL input was not known.

The results, with some effort in minimizing lead lengths, were satisfactory.

An item worthy of mention, is the load. Because the current peaks are quite high, the peak voltage requirement is high. The design of the load resistor required some effort. The width of the output pulse added another factor in creating a suitable load. Several suitable loads were created to verify the adequateness of the load. An assembly of parallel branches of carbon resistors and an assembly using a coaxial structure produced similar results.





Only 2 branches are shown, but actually enough branches were used to achieve $\cong$ 5 ohms. Resistors were 2 watt carbon composition resistors of 18 ohms each.

CONCLUSION:

Task I and II differ only in the PRR as depicted by the specifications.

The actual hardware for Task I and Task II are the same.

The circuitry to accept TTL input has not been tested in the breadboard assembly as of this report. It is the same as employed successfully in Task III of the High Voltage Nanosecond Pulse Generator Program.

The specified volume appears attainable through the final mechanical arrangement has not been made as of this report.

New smaller capacitors for the pulse forming network should be in house within a month.

Indications are that the final prototype configuration will meet the specified requirements.

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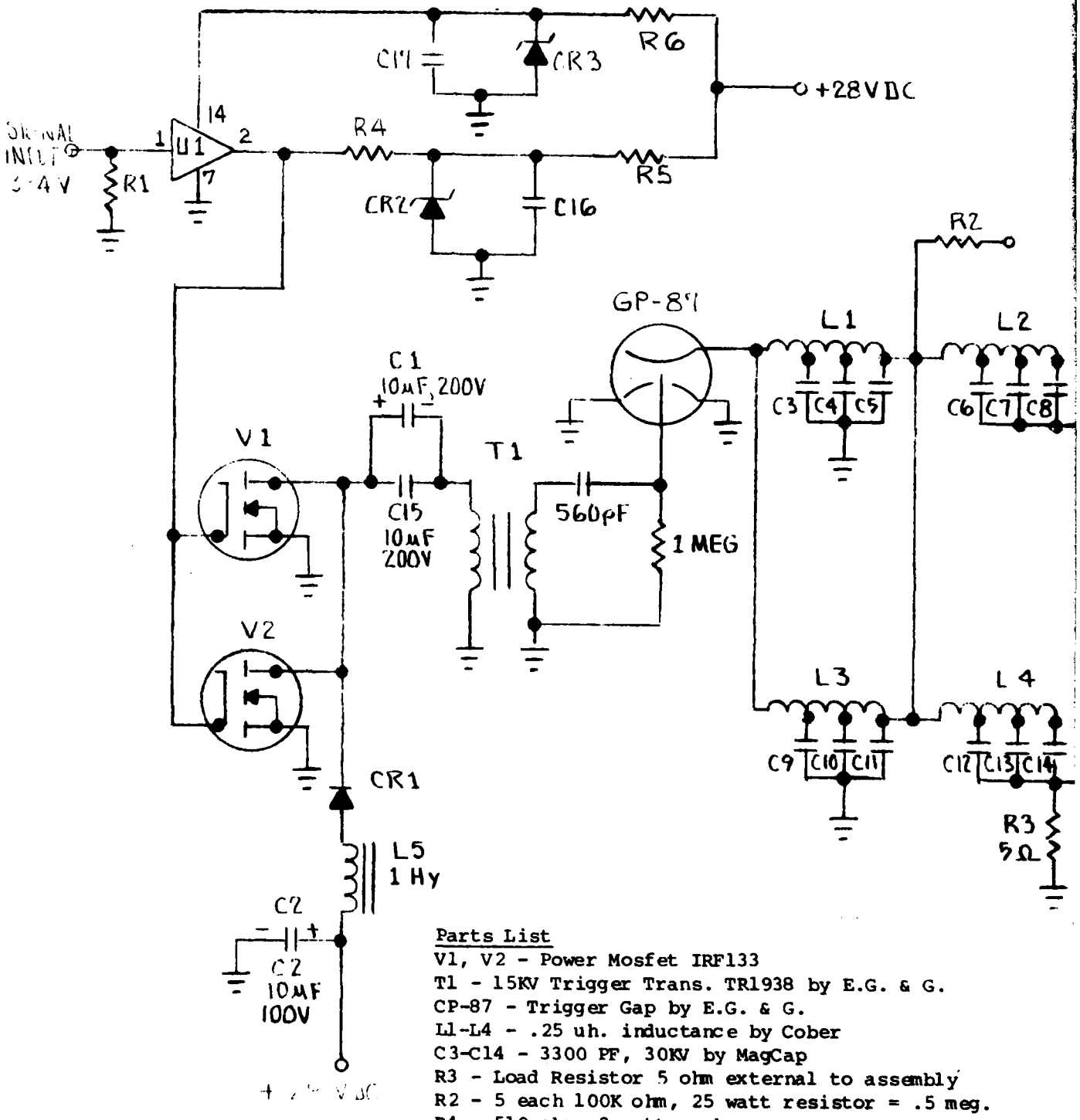
FIGURE IV



Parts List

V1, V2 - Power Mosfet IRF133
T1 - 15KV Trigger Trans. TR1938 by E.G. & G.
CP-87 - Trigger Gap by E.G. & G.
L1-L4 - .25 uh. inductance by Cober
C3-C14 - 3300 PF, 30KV by MagCap
R3 - Load Resistor 5 ohm external to assembly
R2 - 5 each 100K ohm, 25 watt resistor = .5 meg.
R4 - 510 ohm, 2 watt carbon
R5 - 390 ohm, 2 watt carbon
R6 - 390 ohm, 2 watt carbon
U1 - SN7417J
C16, C17 - .47 mfd, 50V
CR1 - 1N4007
CR2 - 1N2024A
CR3 - 1N3826A

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